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Translation of Priority Document

THE KOREAN INTELLECTUAL PROPERTY OFFICE

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Application Number	:	Patent Application No. 41926/2002
Date of Application	:	July 18, 2002
Applicant(s)	:	Samsung Electronics Co., Ltd.

COMMISSIONER

[TITLE OF INVENTION]

COOLING APPARATUS FOR HIGH-SPEED DRAWING

[BRIEF DESCRIPTION OF THE DRAWINGS]

FIG. 1 is a front view showing partially in section a body of a cooling apparatus employed in a conventional drawing tower;

FIG. 2 is a constructional view of an optical fiber drawing apparatus which employs a cooling apparatus in accordance with a preferred of the present invention;

FIG. 3 is a side view showing the external appearance of a cooling apparatus for high-speed drawing in accordance with a preferred of the present invention;

FIG. 4 is a side view showing a layout of turbulence generators in accordance with a preferred embodiment of the present invention;

FIG. 5 is a cross-section view taken along the line X-X;

FIG. 6 is a cross-section view taken along the line Y-Y; and

FIG. 7 is a cross-section view showing the cooling apparatus shown in FIG. 4 in the disassembled state.

[Detailed Description of the Invention]

[Object of the Invention]

[Technical field and Prior Art]

The present invention relates to an optical fiber drawing apparatus for extracting a single strand of optical fiber from a prepared optical fiber preform, and more particularly to a cooling apparatus for high-speed drawing of optical fiber.

Typically a process for manufacturing an optical fiber is divided into a step for preparing an optical fiber preform, and a step for drawing an optical fiber to extract a strand of optical fiber, which is thinner than a hair, from the prepared preform. A lot of research has been made in preparing a large-diameter optical fiber perform, specifically in the process of preparing an optical fiber preform in order to extract a larger number of optical fiber strands from the prepared optical fiber preform. For example, an over-jacket tube method, a rod-in tube method and the like have been occasionally employed in order to manufacture a large-diameter optical fiber preform. Consequently, as a measure for drawing more strands of optical fibers from a prepared optical fiber preform, one should make an effort to manufacture a large-diameter optical fiber preform or to produce a more stable drawing installation.

Through a series of processes as described above, a large-diameter optical fiber perform is prepared and a single optical fiber strand is drawn from the prepared large-diameter optical fiber preform. FIG. 1 shows a conventional cooling apparatus

employed in the process of drawing an optical fiber. As shown in FIG. 1, an optical fiber F1, which is drawn at a high temperature and a high speed, is cooled while passing through a cooling apparatus and made into an optical fiber F2 having a temperature appropriate for coating. The cooling apparatus consists of a cooling body 30, and upper and lower irises 32, 34, which are mounted on upper and lower ends of the cooling body 30, respectively. Each of the irises 32, 34 inhibits the ingress of external air and minute movements of the optical fiber at the time of initial drawing.

The cooling body 30 has a double-walled structure of copper tubes, i.e., comprises a first copper pipe 310 and a second copper pipe 312, wherein the latter is coaxially located within the former. From each of the upper and lower ends of the cooling body 30, helium gas is supplied into the inner space 301 of the second copper pipe 320 in the directions indicated by arrows ①, and thus forms a helium gas atmosphere in the inner space 301. The drawn optical fiber passes through the inner space 301. Furthermore, a space for circulating cooling water 302 of a low temperature is provided between the first copper pipe 310 and the second copper pipe 312 to cool the helium gas contained in the internal space 301 of the second copper pipe, and the cooling water performs heat exchange with the drawn optical fiber F1 in a high temperature. Through the heat exchange, the optical fiber F1 which is drawn in a high temperature is cooled to an appropriate temperature. In order to draw more amount of optical fiber from a prepared optical fiber preform, it is necessary to increase the efficiency of the process so that optical fiber can be drawn in a speed higher than that in the prior art.

However, if an optical fiber is drawn from the preform thereof at a high speed, external air may penetrate into the internal space 301 of the second copper pipe through the upper iris 32. In other words, as the optical fiber is drawn at a high speed, airflow is generated in the region adjacent to the circumferential surface of the optical fiber, and due to the airflow, external air penetrates into the internal space 301 of the second copper pipe, within which the helium atmosphere has been formed, and thus reduces the density of helium within the internal space of the second copper pipe.

In particular, the helium density is more reduced in the region adjacent to the upper iris 32 within the cooling body 30. Such a reduction of helium density is the most important cause of a drop in cooling efficiency and the operator should supply more helium gas than needed to the cooling apparatus in order to compensate the reduction of helium density. Consequently, it is necessary for a manufacturer to supply more helium gas than needed to prevent a drop in efficiency which results from the reduction of helium density and this becomes a cause of increased costs.

[Technical Object of the Invention]

Accordingly, the present invention has been made to solve the above-mentioned problems occurring in the prior art, and it is an object of the present invention is to provide a cooling apparatus which can enhance cooling efficiency to allow high speed drawing.

It is another object of the present invention is to provide a cooling apparatus which can economically use cooling gas.

Also, it is another object of the present invention to provide a cooling apparatus which can increase turbulence in the molecular movements of cooling gas, thereby minimizing the consumed amount of cooling gas.

In order to accomplish the above-mentioned objects, in accordance with the present invention, there is provided a cooling apparatus employed in the drawing process of an optical fiber, comprising: a cooling body extending along the longitudinal direction of the drawn optical fiber, wherein the cooling body consists of a left cooling body part and a right cooling body part which are separable and the cooling body is provided with a sealing cap so that cooling gas can be supplied into the cooling body through the sealing cap; and at least one turbulence generator which is mounted within the cooling body to surround the drawn optical fiber, the turbulence generator activating molecular movement of the cooling gas supplied into the cooling body.

[Construction and Operation of the Invention]

The above and other objects, features and advantages of the present invention will be more apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a front view showing partially in section a body of a cooling apparatus employed in a conventional drawing tower;

FIG. 2 is a constructional view of an optical fiber drawing apparatus which employs a cooling apparatus in accordance with a preferred of the present invention;

FIG. 3 is a side view showing the external appearance of a cooling apparatus for high-speed drawing in accordance with a preferred of the present invention;

FIG. 4 is a side view showing a layout of turbulence generators in accordance with a preferred embodiment of the present invention;

FIG. 5 is a cross-section view taken along the line X-X;

FIG. 6 is a cross-section view taken along the line Y-Y; and

FIG. 7 is a cross-section view showing the cooling apparatus shown in FIG. 4 in the disassembled state.

Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings. In the following description of the present invention, a detailed description of known functions and configurations

incorporated herein will be omitted when it may make the subject matter of the present invention rather unclear.

FIG. 2 is a construction view schematically showing optical fiber drawing facilities mounted within a drawing tower. FIG. 2 shows two cooling apparatus 10 for high-speed drawing of the present invention employed in the optical fiber drawing facilities. As shown in FIG. 2, a process for drawing an optical fiber is sequentially performed in one drawing tower (the height of which is at least 10 m) in the vertical direction step by step. A preform P of optical fiber, which is provided centered on the vertical axis of the drawing tower, is melted within a melting furnace 8 to a sufficiently high temperature and is drawn to a single strand optical fiber F1. The drawn optical fiber F1 is controlled in size of diameter by a diameter controller 9, and passes through the cooling apparatus 10 of the present invention, thus being cooled to a temperature appropriate for coating of a cladding before it is coated with the cladding. The cooled optical fiber F2 is coated with a cladding while passing through a coating device 16 and then ultraviolet (UV) curable polymer which has been coated on the circumferential surface of the optical fiber is cured while the optical fiber passes a UV curing device 18.

Following this, the optical fiber which has passed through the curing device passes a capstan 19 and a plurality of guide rollers 22, 24 and then the optical fiber is wound on a winding unit 26. The capstan 19 provides a predetermined drawing force, so that an optical fiber with a constant diameter can be drawn from the optical fiber preform. A series of the aforementioned drawing facilities are mounted within the stand type drawing tower in the sequence of steps to be performed. Reference numeral 26a indicates a reel or a spool to which the optical fiber is finally wound.

Each of the optical fiber drawing facilities mounted within the optical fiber drawing tower is maintained with a vertical or horizontal relationship as to the other facilities as well as the entire basic frame, and has a construction impervious to vibration or impact. In particular, the cooling apparatus 10 serves to evenly cool the drawn optical fiber F1.

The vertical height of the drawing tower shown in the drawings exceeds about 10 m, and the optical fiber drawn from one optical fiber preform P will have a vertical span exceeding about 10 m. The cooling apparatus 10 performs the function of cooling the optical fiber F1 to about 40 °C, because the optical fiber F1 is drawn at a high temperature and high speed.

The construction of the cooling apparatus in accordance with the present invention will be described with reference to FIGs. 3 to 7. As shown in FIGs. 3 and 4, the cooling apparatus 10 for high-speed drawing (hereinafter, to be referred as "cooling apparatus") is employed in an optical fiber drawing installation to cool an optical fiber to a desired temperature appropriate for coating the drawn optical fiber. The cooling

apparatus is so constructed that it can be automatically opened, closed and controlled. For the convenience of description, a means for automatically opening, closing, and controlling the cooling apparatus is not shown because this may make the subject matter of the present invention unclear. It should be noted that at least one cooling apparatus can be mounted in the drawing tower. FIG. 2 shows a state in which two cooling apparatuses are installed. In addition, each of the cooling apparatuses according to the present invention is a high-efficiency cooling apparatus. in which a turbulence generator is provided within a cooling body 110, thereby minimizing the used amount of cooling gas utilized as a refrigerant (He, Ar, N_2). FIG. 3 is a side view showing an external appearance of the cooling apparatus according to the present invention. In the drawing, an optical fiber which would be concealed by the cooling body is illustrated. FIG. 4 shows a state in which four turbulence generators are employed and mounted within the cooling apparatus in accordance with the present invention.

In specific, the cooling apparatus 10 comprises a left-right separable cooling body which is composed of a left cooling body part 112, and a right cooling body part 114; upper and lower sealing caps 120, 130 which are provided on the upper and lower ends of the cooling body 110, respectively, to block the ingress of external air, wherein cooling gas is supplied into the cooling body through the sealing caps; at least one turbulence generator 140 which is positioned at a predetermined position in the longitudinal direction of the cooling body 110 to further activate the molecular movements of the cooling gas introduced into the cooling body 110.

The cooling body 110 is extended to a predetermined length in the longitudinal direction of the optical fiber F1 and allows the optical fiber which is drawn along the longitudinal center line within the cooling body to be cooled to an appropriate temperature. The upper and lower sealing caps 120, 130 are provided to prohibit the ingress of external air produced during high-speed drawing, in particular by providing a counter-flow. In FIG. 3, the left cooling body part 112 and right cooling body part 114 are integrally assembled by adjoining them the direction indicated by arrows A and disassembled by separating them in the direction indicated by arrows B.

The turbulence generator 140 serves to cause the molecular flow of the cooling gas (e.g. helium gas), which is supplied to the interior of the integrally assembled cooling body 110, to be turbulenced, and thus the turbulence generator 140 serves to maximize the cooling efficiency. Each of the left side cooling part 112 and right side cooling part 114 is provided with one turbulence generator 140, and at least one turbulence generator is provided in the longitudinal direction of the cooling body 110. In addition, the turbulence generators are mounted in the left side cooling part 112 and right side cooling part 114 in a symmetrical fashion. Because the turbulence generators 140 communicate with the atmosphere surrounding the external

circumference of the drawn optical fiber F1, through slots S, the optical fiber F1 is directly influenced by the turbulent movements of the cooling gas caused by the turbulence generators.

As shown in FIGs. 5 to 7, the left and right cooling body parts 112, 114 are supplied with cooling water W of low temperature without intermission and the cooling water continuously circulates from a predetermined position. The cooling water W absorbs heat from the cooling body 110 heated by the drawn optical fiber F1 and thus primarily cools the atmosphere surrounding the optical fiber F1.

In addition, the left and right cooling body parts 112, 114 are provided with helium gas 146 which is supplied to cool the atmosphere surrounding the optical fiber F1. Both of the cooling water W and helium gas 146 are symmetrically stored and supplied in the left and right cooling body parts 112, 114. The cooling water W is provided to continuously circulate in the longitudinal direction of the cooling body and the helium gas 146, the cooling gas being provided in the circumferential direction of the drawn optical fiber F1 to be directed toward the surface of the optical fiber.

Specifically, the turbulence generators 140 are preferably composed of cooling fans, and the slots S are provided so that the ventilation produced by the cooling fans 140 produces turbulence and is communicated with the drawn optical fiber F1. The ventilation caused by the cooling fans 140 directly influences on the optical fiber F1 and thus maximizes the cooling efficiency. Although the drawn optical fiber runs at a high speed, the cooling efficiency of the helium gas can be maximized because the ventilated flow provided in the circumferential direction of the optical fiber F1 by the cooling fans 140 is mixed with the helium gas 146 and directly contacts with the optical fiber F1.

In addition, at least one vibration-damping jig 142 is mounted in the longitudinal direction of the drawn optical fiber F1, especially between the cooling fans 140 and the optical fiber F1 and thus maintains the evenness of the quality of cooling the optical fiber by the supplied cooling gas 146. The vibration-damping jig 142 consists of two members which have a predetermined curvature radius and face each other symmetrically with reference to the drawn optical fiber F1.

Consequently, the cooling gas 146 turbulenced by the cooling fans 140 meets the high temperature optical being drawn at a high speed, and the turbulent cooling gas contacts with and its high molecular movement serves to actively cool the surface of the optical fiber.

The operation of the cooling apparatus 10 constructed as described in the above will be specifically described. At the time of drawing an optical fiber from the optical fiber preform which is positioned in the melting furnace and has undergone preheating and heating processes, if the drawing velocity of the optical fiber F1 (the linear velocity is about 200 ~ 500 meter per minute: mpm) increases, thus applying a basic tension to

the optical fiber F1, the left and right cooling body parts 112 and 114 are joined together to form a single body, i.e. the cooling body 110. At the same time, the upper and lower caps 120 and 130 are integrally engaged to the cooling body 140 and then the cooling gas 146 is supplied to the cooling body 110. Following this, if the linear velocity of the basically tensioned and drawn optical fiber reaches to about 700 ~ 1000 mpm, the turbulence generators 140 are operated. The turbulence generators 140 increasingly activate the molecular movements of the cooling gas 146 with their production of turbulence, and the cooling gas supplied through the slots S absorbs and transfers heat from the surface of the optical fiber F1 to the surface of the cooling body 110, the slots S being provided through the internal wall of the cooling body 110 and extending vertical to the drawn optical fiber F1.

Thereafter, if the optical fiber is severed or terminated, the cooling body parts will automatically moved apart from each other, thus opening the cooling body and the drawing process will be terminated without needing a separate flush step. Preferably, the quality of cooling the optical fiber by the cooling gas is uniformly maintained by the vibration-damping jigs 142 provided in the cooling body 110 along the longitudinal direction of the drawn optical fiber F1. A drawing tower may be provided with at least one cooling apparatus according to the present invention and it is preferable to employ two cooling apparatuses 10. FIG. 2 shows a drawing tower which employs two cooling apparatuses 10.

While the invention has been shown and described with reference to certain preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

[Effect of the Invention]

As appreciated from the above, the cooling apparatus according to the present invention allows high-speed drawing by using a turbulence generator, thereby being capable of enhancing the productivity of optical fiber. Furthermore, the present invention can largely reduce the amount of cooling gas consumed by using turbulence generators, thereby increasing the competitiveness of costs.

WHAT IS CLAIMED IS:

1. A cooling apparatus employed in the drawing process of optical fiber, comprising:

(A) a cooling body which extends along the longitudinal direction of a drawn optical fiber, wherein the cooling body consists of a left cooling body part and a right cooling body part which are separable from each other and wherein the cooling body is provided with a sealing cap such that cooling gas can be supplied into the cooling body through the sealing cap; and

(B) at least one turbulence generator which is mounted within the cooling body to surround the drawn optical fiber, the turbulence generator activating the molecular flow of the cooling gas supplied into the cooling body.

2. The cooling apparatus in accordance with claim 1, wherein the cooling apparatus comprises two or more turbulence generators, and the turbulence generators are mounted in a symmetrical fashion.

3. The cooling apparatus in accordance with claim 1, wherein the cooling apparatus comprises two or more turbulence generators, and the turbulence generators are mounted along the longitudinal direction of the cooling body in a stacked structure.

4. The cooling apparatus in accordance with claim 1, wherein the cooling apparatus body further comprises at least one vibration-damping jig which is located between the turbulence generator and the drawn optical fiber to uniformly maintain the quality of cooling the optical fiber.

5. The cooling apparatus in accordance with claim 4, wherein at least one vibration-damping jig is positioned along the drawn optical fiber.

6. The cooling apparatus in accordance with claim 4, wherein the cooling apparatus body comprises two or more vibration-damping jigs and the vibration-damping jigs are symmetrically mounted in the cooling body.

7. The cooling apparatus in accordance with claim 1, wherein the turbulence generator is provided with at least one slot which enables the turbulence generator to communicate with the inside of the cooling body through which the drawn high temperature optical fiber passes.

8. The cooling apparatus in accordance with claim 1, wherein the turbulence generator is composed of cooling fans.

ABSTRACT

Disclosed is a cooling apparatus for high-speed cooling, employed in a process of drawing an optical fiber. The cooling apparatus includes: a cooling body extending along the longitudinal direction of the drawn optical fiber, wherein the cooling body consists of a left cooling body part and a right cooling body part which are separable from each other and the cooling body is provided with a sealing cap so that a cooling gas is supplied into the cooling body through the sealing cap; and at least one turbulence generator which is mounted within the cooling body to surround the drawn optical fiber. The turbulence generator activates the molecular flow of the cooling gas supplied into the cooling body.